PRELIMINARY DEVELOPMENT PLAN
for
COLORADO TRACT C-b

PROTOTYPE OIL SHALE LEASING PROGRAM
U.S. DEPARTMENT OF THE INTERIOR

ASHLAND OIL, INC
ATLANTIC RICHFIELD COMPANY
THE OIL SHALE CORPORATION
SHELL OIL COMPANY

PRELIMINARY DEVELOPMENT PLAN
FOR
COLORADO TRACT C-b

PROTOTYPE OIL SHALE LEASING PROGRAM
U. S. DEPARTMENT OF THE INTERIOR

Submitted to:
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U. S. Department of the Interior
Denver, Colorado

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TABLE OF CONTENTS

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I. INTRODUCTION

This Preliminary Development Plan is submitted by the successful bidding group for Colorado Tract C-b; Ashland Oil, Inc., Atlantic Richfield Company, The Oil Shale Corporation and Shell Oil Company (hereinafter the "Lessees"), in conformity with the requirements set forth in the Notice of Sale published in the Federal Register on November 30, 1973, December 10, 1973, and January 11, 1974.

All of the Lessees are engaged in petroleum refining and marketing operations in the United States and have capabilities in mining, oil production, refining, marketing and oil shale research. Ashland, Atlantic Richfield and Shell have extensive conventional oil production and Ashland participates in substantial mining activities including coal, limestone and traprock. Atlantic Richfield and The Oil Shale Corporation are participants in Colony Development Operation, a joint venture which has completed a large scale experimental project demonstrating the feasibility of shale oil recovery techniques, including mining, retorting and environmental control measures.

Since the announcement of the Prototype Oil Shale Leasing Program, the Lessees have been active in exploratory and evaluative studies of

Tract C-b. Based on these investigations, the Lessees believe that timely development of the Tract is possible, and are prepared to commence in the manner described in this Plan.

This Preliminary Development Plan, which describes the general plan and intent of the Lessees, has four major sections to conform with the Government's outline in the Notice of Sale:

Proposed Method of Development

Proposed Location of On-Site and Off-Site Facilities

Environmental Monitoring Program

Proposed Schedule for Development

Further detailed descriptions of the proposed lease development activities will be included in the Exploration Plan to be submitted as soon as specific plans are completed, and in the required Detailed Development Plan to be submitted on or before the third anniversary date of the Lease. In addition, other reports will be submitted to the Mining Supervisor on a frequent basis in compliance with the terms of the Lease. This Preliminary Development Plan is, therefore, tentative and as instructed in the Notice of Sale, it is submitted to primarily serve as a guide to the Lessor in establishing initial supervision of the Lessees' activities. Where possible, the Lessees have provided estimates and plans, which, while subject to change, may help the Lessor in overall regional oil shale planning considerations.

The exploratory and environmental studies proposed in this Preliminary Development Plan will be designed to supplement rather than duplicate the extensive environmental investigations described in the U. S. Department of Interior's Final Environmental Statement for the Prototype Oil Shale Leasing Program and the extensive environmental information available to the Lessees through Colony Development Operation.

II. PROPOSED METHOD OF DEVELOPMENT

A. Introduction

The Lessees propose to develop Tract C-b by conventional underground mining methods. Shale oil will be recovered in surface retorts and either transported by pipeline directly to market or further refined on the plant site to hydrotreated shale oil before transportation. It is expected that an initial commercial plant will be designed to produce about 50,000 barrels per day of shale oil with possible later expansion to an aggregate capacity of up to 100,000 barrels per day. A description of the contemplated operations is presented in this section. Details will be provided in the forthcoming Exploration Plan and the Detailed Development Plan which is due on or before the third anniversary date.

B. Physical Setting of Tract

1. Topography

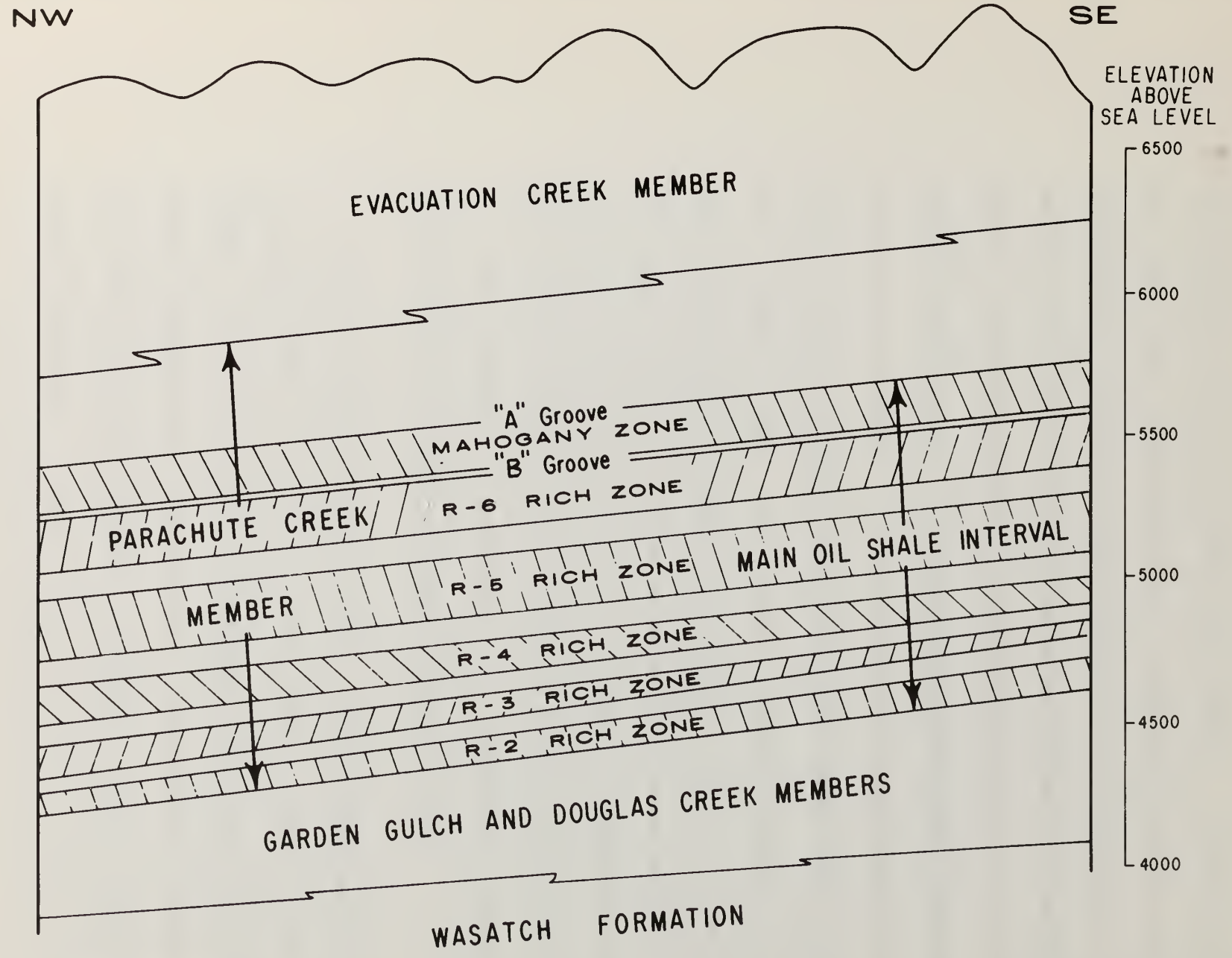
Tract C-b is located in the southeast portion of the Piceance topographic basin just south of Piceance Creek. Here, the tributaries of this drainage have sculptured the landscape into a series of alternating north-trending broad rounded ridges and narrow valleys. Elevations within the Tract range from about 7,000 feet on the ridges at the south to about 6,400 feet in the valleys at the north. Maximum relief between the valley floor and the ridge crest is about 300 feet.

2. Geology

The Tract is located in the southeastern portion of the Piceance Creek structural basin about twelve miles west of the Grand Hogback. The major subregional structural feature in this part of the basin is the Hunter Creek syncline. The Tract lies immediately south of the axis of this east-west trending depression, and the beds uniformly dip to the northwest at a rate of 100-150 feet per mile.

A well-developed natural fracturing or jointing system is evident in the surface rocks throughout the Piceance Creek Basin. Several fracture sets have been mapped in the vicinity of the Tract with the dominant set trending about N70°W. No faulting has been reported within the Tract boundaries.

The Evacuation Creek member of the Green River formation comprises the surface rocks over the Tract, as shown in Figure 1. Consisting mostly of interbedded sandstone, siltstone and marlstone, this unit ranges from about 400 to 900 feet in thickness across the Tract. The Parachute Creek member underlies the Evacuation Creek member and is mainly comprised of organic marlstone (oil shale) of varying richness. This unit, which averages about 1,600 feet in thickness, is discussed below in greater detail. The Garden Gulch and Douglas Creek members underlie the Parachute Creek member. These units are undifferentiated at the Tract and are mostly comprised of interbedded true shale and organic marlstone (oil shale).



0 1 2 3 4 5

SCALE IN THOUSANDS OF FEET

NOTE: RICH ZONES SELECTED TO CONFORM WITH U.S.G.S. TERMINOLOGY IN OIL & GAS INVESTIGATION CHART OC 65.

FIGURE 1

GENERALIZED SE-NW CROSS SECTION ACROSS TRACT C-b

The lower two-thirds of the Parachute Creek member contains the formation's principle oil shale beds (Figure 1). Although some rich shales occur immediately above and below this interval, the thickest rich oil shales are mostly limited to this stratigraphic section. The main oil shale interval is not uniform in oil content from top to bottom but consists rather of alternating rich and relatively leaner oil shale zones. In accordance with established terminology (Cashion and Donnell, 1972, USGS Oil and Gas Investigation Chart OC65), the rich oil shales have been divided into six zones, separated by leaner oil shale. The uppermost interval is the well-known Mahogany Zone which contains the formation's richest oil shale beds. Underlying this interval are the R-6 through R-2 zones which are comprised of oil shale beds of lesser richness. Available data indicates that the Mahogany Zone beneath the Tract contains about 75 feet of oil shale averaging 35 gallons per ton. In addition, portions of Zones R-6 and R-2 probably average 30 gallons per ton.

Based on regional geologic studies, both nahcolite and dawsonite are present within the Tract in the lower portion of the Parachute Creek member. However, the Tract is peripheral to the main area of saline mineral deposition and lesser amounts of these minerals are present here than at the basin depocenter. Nahcolite, naturally occurring sodium bicarbonate, is present mostly as isolated nodules, but may

be found in beds in the northwestern portion of the Tract. Dawsonite, a sodium aluminum carbonate, is present in varying amounts through the lower 500 -600 feet of the Parachute Creek member.

Overburden to the top of the Mahogany Zone ranges from about 900 to 1,300 feet in thickness. As the land surface and the beds both dip to the north at about the same rate, changes in overburden thickness mostly reflect local variations in topographic relief.

3. Ground Water

Two bedrock aquifer systems are indicated to be present in the Green River formation of the Piceance Creek Basin. The upper bedrock aquifer encompasses the interval from the ground surface to the base of the Mahogany Zone and the lower aquifer (sometimes called the leached zone) extends from the base of the Mahogany Zone to the base of the open fracture system. Beneath Tract C-b the open fractures extend 500 feet or more below the Mahogany Zone.

Recently published data (Ficke, et al, 1973, "Selected Hydrologic Data from the Piceance Basin, Colorado, USGS Open File Report") from several core holes drilled on and near the Tract suggest that the upper and lower aquifers are communicating in this area but, only to a very minor degree. A comparison of temperature, discharge and conductivity measurements indicate that the upper Parachute Creek member contains the most permeable rocks in the section. The

overlying Evacuation Creek member contains relatively little mobile ground water.

The specific conductance of water produced during drilling of the post-Mahogany Zone rocks indicates a dissolved solids content ranging from about 500 to 1500 parts per million. In general conductance increases with depth and in the beds below the Mahogany Zone water has been encountered with a dissolved solids content of more than 3000 parts per million.

Potentiometric maps of the area indicate that the free-standing water level in wells is essentially at surface elevation along the major drainage transecting the Tract. Depth to the potentiometric surface along the ridges in a function of topographic relief above the stream bottoms.

C. Mining

The initial mining operation contemplated will extract oil shale from an interval within the Mahogany Zone by room and pillar mining. The thickness of the overburden (more than 900 feet) presently precludes consideration of development by open pit mining. In situ methods are not contemplated for the initial operations.

The Lessees anticipate that the initial mining plan will be based on the extraction of oil shale at rates sufficient to produce about 50,000 barrels of shale oil per day. For this rate, with an oil shale richness of 35 gallons per ton, the retort feed requirement is about 65,000 tons of

crushed oil shale per day (about 22 million tons per year).

Considerable preproduction (before plant startup) mining will be required to bring the mine into production. Early in this period an understanding of the actual underground conditions will be developed for use in the final design of the mine.

There are other oil shale intervals under the Tract and expansion of the initial operation beyond the 50,000 barrels per day rate might be undertaken as soon as environmental, operating and economic factors indicate that a larger operation could be justified. Expansion could be accomplished by using in situ methods to recover additional shale oil from completed underground mined out areas if appropriate in situ methods are developed and demonstrated. Other oil shale intervals below the Mahogany Zone contain reserves in excess of the requirements of the initial contemplated oil shale complex and could be used to achieve expanded production. These reserves could be mined using underground room and pillar methods to increase aggregate production to as much as 100,000 barrels per day. The lower oil shale zones also contain other minerals, such as nacholite and dawsonite. The feasibility of mining and processing these minerals, including the extraction of alumina from spent shale, will be investigated. Over the long term, the objective would be to maximize recovery of the oil shale under the Tract in a manner compatible with economic and environmental considerations.

The initial mine plan will likely be based on current oil shale

technology and conventional mining techniques and equipment as demonstrated by Colony Development Operation at their Parachute Creek mine. Although future developments in mining technology could lead to improved techniques for underground mining of oil shale, the initial mine plan is expected to be based on conventional techniques as described herein.

Access to the mining zones from the surface will be through inclined or vertical shafts. Inclined shafts would permit belt haulage to the surface. Oil shale, after primary crushing, will be removed from underground through the inclined or vertical shafts and transported by overland conveyors to the coarse ore stockpile - secondary crushing area near the plant. Vertical shafts probably will be used for transporting men and equipment to the underground working areas.

A typical two-bench room and pillar mining operation is illustrated in Figure 2. Mining will proceed by the conventional mining cycle of of drilling, charging, blasting, wetting of rock piles, loading, hauling, scaling and roof bolting. All phases of the mining cycle, except blasting, may occur simultaneously in various areas of the mine. Blasting will only occur during shift changes at which time no personnel will be in the immediate area.

Mine ventilation will be provided by a forced air system. Fresh air will be drawn into the mine through the inclined and/or vertical service shafts. Fresh air will be directed along the airways into the

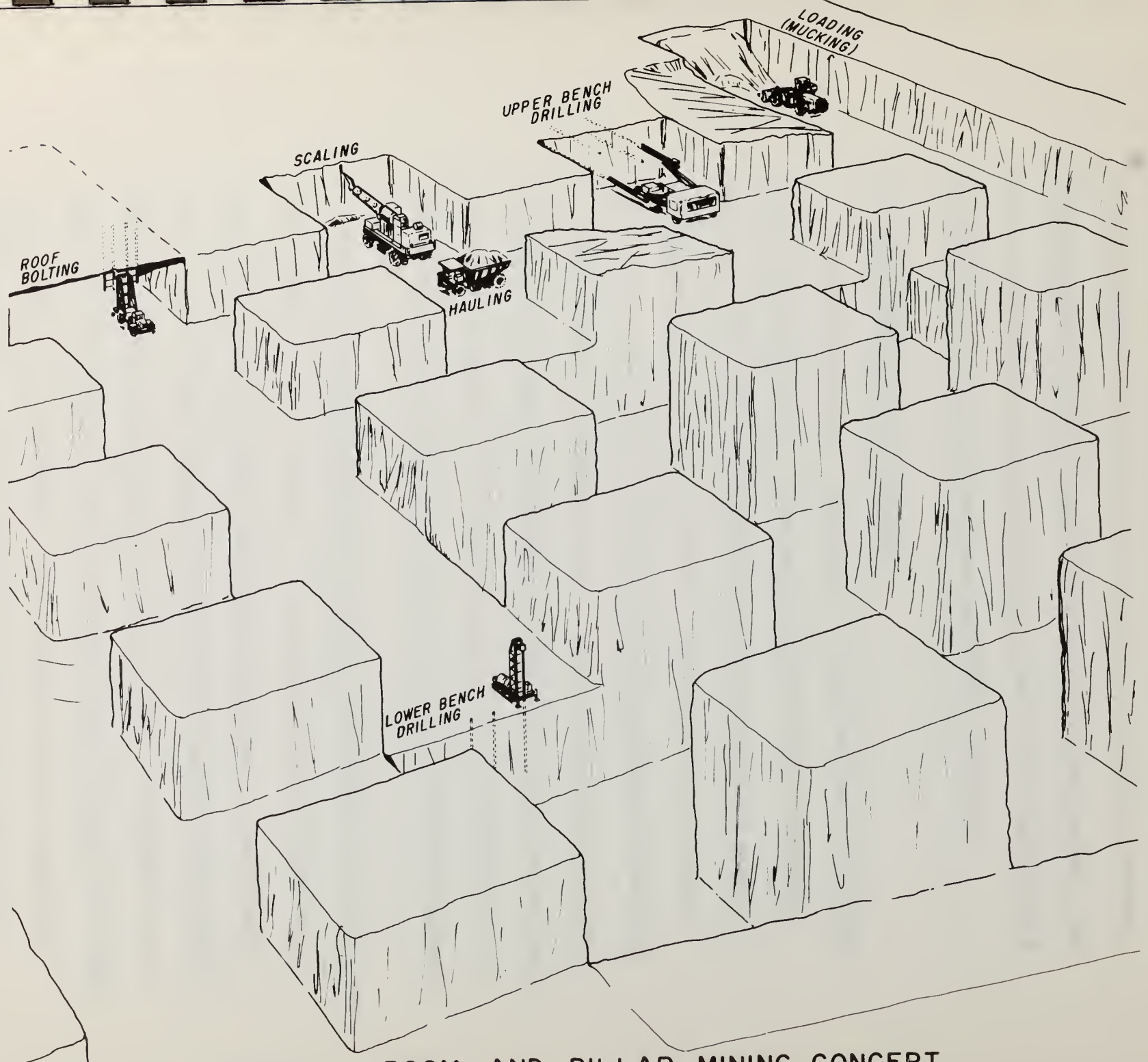


Figure 2 ROOM - AND - PILLAR MINING CONCEPT

operating areas, and swept along the working faces by auxiliary fans. The underground air flow will be directed and controlled by brattices, stoppings and air doors to prevent short circuiting where needed. Air volume requirements will be as required by good mining practices and in accordance with Federal and State regulations and codes.

D. Mine Dewatering and Disposal

In the proposed mine development, a significant amount of ground water may be encountered. The Lessees plan to conduct hydrology studies to determine the amount and quality of underground water. Dewatering may have to be carried out ahead of the mine development. If so, deep wells could be drilled in an expanding pattern from the initial location of mining activity. By initiating pumping from this expanding well system, and keeping considerably ahead of the advancing tunnels, a relatively dry mine should result. Gradual expansion of the well system will be coordinated with the progress of the mining operation.

During the initial dewatering operation, the ground water is expected to be of high quality. However, if low quality water containing salt in high concentration, or other undesirable constituents, is encountered, environmentally sound methods for disposing or using the water will be employed. During the preproduction mining period, low quality ground water could be stored in a reservoir for later use in the plant or for spent shale wetting and compaction. Later the water could be evaporated during the warm season from a sprinkler system in the spent shale

disposal area. When the evaporation system cannot be used, water can be bypassed to a storage reservoir for later use or disposal. The ground water storage and disposal system will be designed to collect and recycle surface runoff and to avoid surface percolation. Protection against downstream contamination will be provided by impervious dikes constructed at the downstream toe of the disposal area.

Other methods for disposing of ground water, such as water treating or injection into high salinity aquifers, could be utilized if determined to be practical and in compliance with environmental regulations.

E. Crushing and Conveying

The crushing operation will reduce run-of-mine shale in two stages to a retort size of minus one-half inch. The primary crusher will be located in the mine and the secondary crusher will be located on the surface. A conveyor system will be used to transport crushed shale between primary and secondary crushing and intermediate storage areas, and the retort.

The crushing operation probably will include a large open storage pile of primary crushed coarse ore and a small closed storage of secondary crushed ore. The size of these inventories will be designed to provide continuous feed to the retorts and to smooth out the mine-plant interactions, including planned and unscheduled crusher downtime.

No storage facility for run-of-mine ore is anticipated.

During the mine preproduction period after the primary crusher is installed, coarse ore will be stockpiled for plant startup. The size of the preproduction stockpile will depend on the scheduled mine and plant startup dates and the relative production buildup rates for the mine and plant.

Dust control will be achieved through conventional systems employing suppression and/or collection and covered conveyors will be used to minimize dust emissions.

F. Retorting and Upgrading

This Preliminary Development Plan assumes use of the TOSCO II Process for retorting because this process, including extensive environmental protection procedures, has been successfully tested in large scale (1,000 ton per day) development facilities. Figure 3, is a schematic diagram of the TOSCO II Process. In the TOSCO II retorting system, preheated oil shale and hot ceramic balls are fed to a pyrolysis drum. The hot processed shale is separated from the hydrocarbon vapors and balls by passage through a trommel and accumulator. The processed shale is cooled, moistened and moved to disposal sites. The balls are recycled and reheated in a ball heater. The flue gas from the ball heater is used to preheat the crushed oil shale. The hydrocarbon vapors are fractionated into residual oil, gas oil and naphtha fractions and light hydrocarbon vapors. Particulate and other emissions from the process

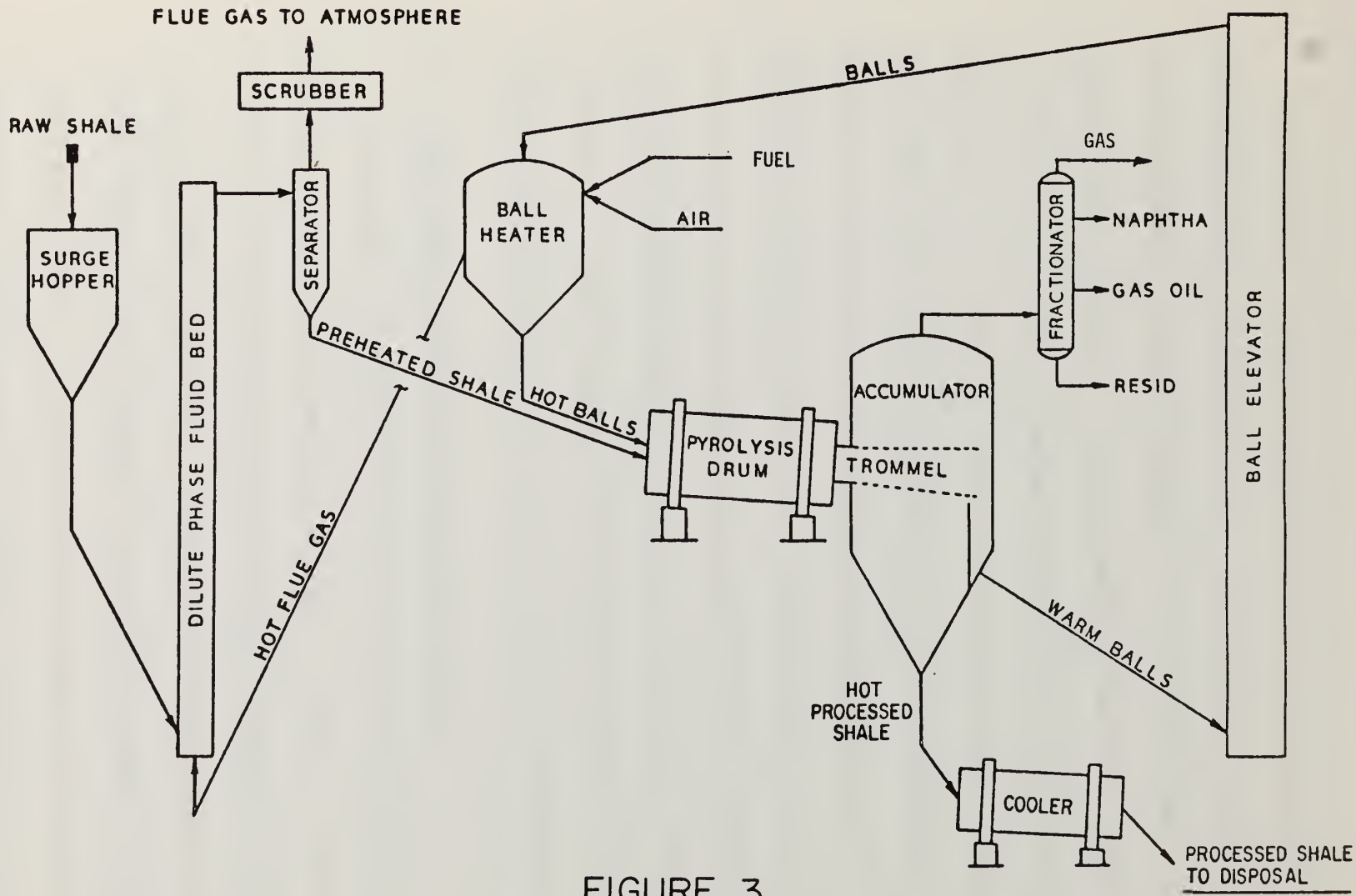


FIGURE 3
TOSCO II PROCESS

will be controlled to meet environmental regulations.

Conventional petroleum refining processes can be used to upgrade the crude shale oil at the plant site. Alternatively, crude shale oil may be transported to upgrading facilities closer to the market. The finished product slate will depend on market factors at the time of plant design; however, it is currently expected that raw shale oil will be upgraded to synthetic crude or fuel oil product at the Colorado site. A typical upgrading scheme will produce substantially sulfur-free hydrotreated shale oil which is a mixture of premium quality distillate products. By simple distillation it can be separated into a naphtha stream, which is suitable for conversion to gasoline or substitute natural gas, and fuel oils for home and industrial heating. Alternatively, the entire hydrotreated oil product can be used as a petrochemical plant feedstock or used directly, without further treatment, as a premium fuel oil for power generation.

G. Spent Shale Disposal and Surface Restoration

The Lessees anticipate that spent shale will be placed on or nearby the Tract to partially fill existing canyons or gulches. All of the spent shale from a 50,000 barrel per day plant can be placed in disposal areas within the Tract boundaries. However, the most environmentally accepted initial surface disposal location may involve the use of a canyon or gulch mainly on the Tract but involving some contiguous land beyond the Tract boundaries. The Government has already recognized this possible need and mentioned it in their leasing program environmental impact statement.

Although surface disposal appears to be the only practical alternative during the initial operating years and must be used to some extent in any event, the Lessees plan to continue to investigate underground disposal techniques. This Preliminary Development Plan emphasizes surface disposal because a practical and environmentally acceptable underground disposal technique has not been developed. The compatibility of underground disposal of spent shale and future recovery of remaining in-place resources from a conventional underground mine and the environmental consequences of such operations also need to be better understood.

When conducting surface disposal operations, the Lessees will add water to the spent shale prior to emplacement to control dust and to develop optimum compaction characteristics. Saline ground water produced from the mine possibly could be used for spent shale wetting. Spent shale will be transported to disposal sites where it will be spread and compacted into terraced embankments to be revegetated at the earliest practicable time.

The Lessees have available extensive experimental data on disposal and revegetation of spent shale in conjunction with Colony Development Operation at its 1,000 ton per day demonstration plant located north of Grand Valley, Colorado. However, it may be necessary to set up an actual spent shale test plot on Tract C-b to determine the on-site revegetation techniques for the particular disposal sites selected (elevation, sun exposure, moisture, native species).

Studies already completed have demonstrated that pollution of both underground and surface waters can be avoided with surface disposal of spent shale. These completed studies indicate that although water may permeate spent shale to relatively shallow depths of up to 24 to 30 inches, the embankments appear to resist deeper penetration of moisture regardless of the amounts of water applied to the surface. As a result, except for movement through this relatively shallow zone, water used to moisturize the spent shale is retained by the embankment. Pollution of surface streams can be avoided by construction of dams upstream and downstream of the embankment to restrict flow of water into the disposal area and to collect runoff of precipitation from the disposal area. Water thus collected can be used in the processing operation or for moisture addition to the spent shale.

All spent shale disposal embankments will be established to provide contours blending, to the extent practical, with the present topography and will then be revegetated. Tests conducted by Colony Development Operation and others have shown that revegetation can be successfully established on spent shale when the material is leached with fresh water to reduce salinity, fertilized, mulched and irrigated. The Lessees will submit as part of the Exploration Plan and Detailed Development Plan an erosion control and surface rehabilitation plan including revegetation programs.

III. PROPOSED LOCATION OF ON-SITE AND OFF-SITE FACILITIES

A. Introduction

The development of Tract C-b will require the construction of surface facilities on and near the Tract. Possible locations of on-site and off-site facilities for a 50,000 barrel per day complex are shown in Figure 4. Surface area will be required for (1) mine shafts and associated facilities, (2) process plant facilities, (3) spent shale disposal, (4) water storage reservoir, and (5) transportation and utility corridors. Extensive engineering and environmental investigations need to be conducted before precise sites for these facilities are recommended. Although the locations of the facilities shown in Figure 4 may change as a result of these studies, the total surface land usage should remain approximately constant. The necessary studies will be conducted during the exploration program and the resulting operational plans will be set forth in the Detailed Development Plan.

During the exploration program, minimum disturbance of the surface is anticipated. Use of existing roads and trails will be made whenever possible. The forthcoming Exploration Plan will describe the operations contemplated during the exploration period.

B. Mine Facilities

The surface mine facilities will consist of openings for the inclined and/or vertical shafts, which are used to access the underground mining zone. These facilities will be within the boundaries of the

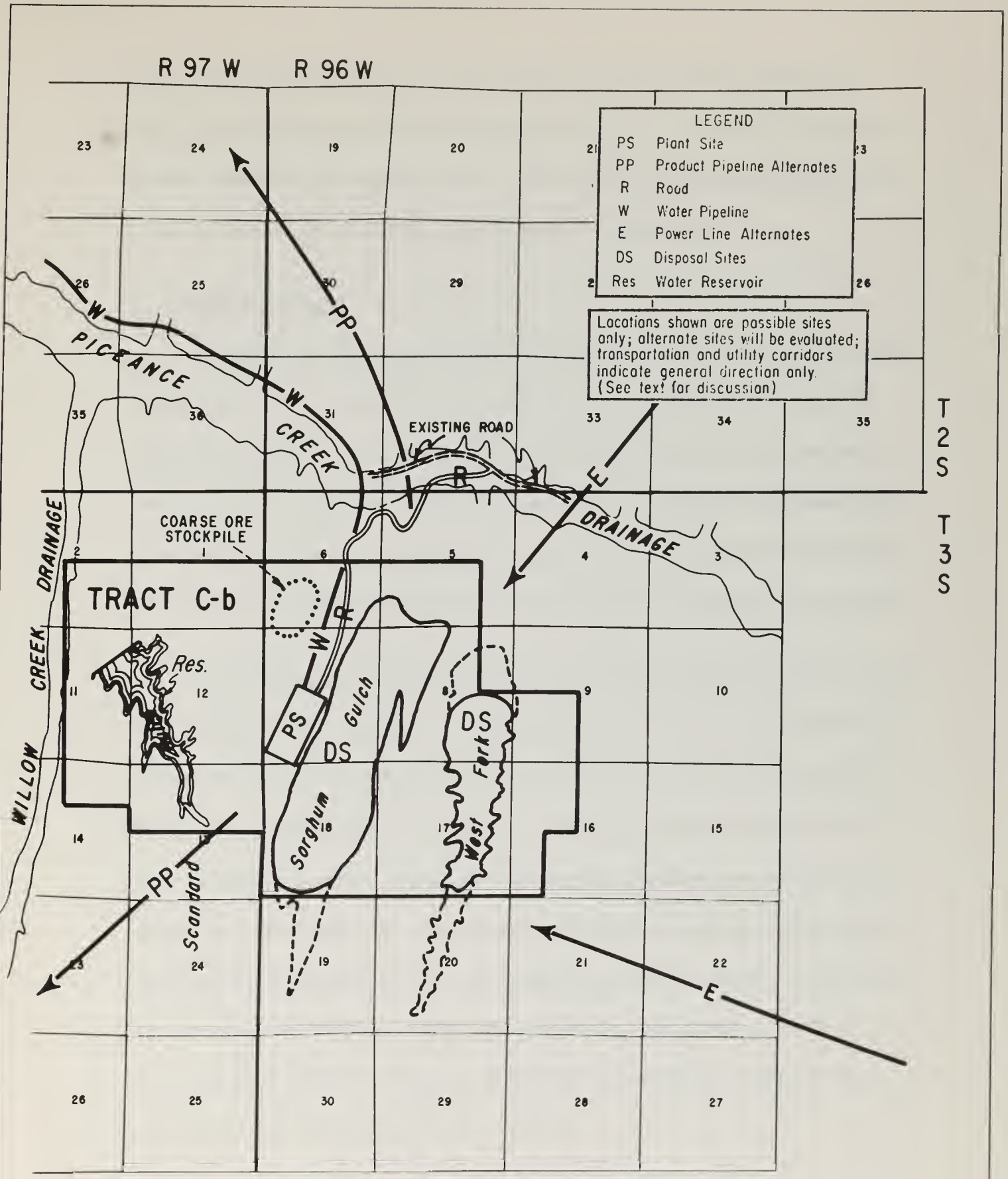


FIGURE 4

POSSIBLE LOCATION OF ON-SITE AND OFF-SITE FACILITIES

Tract. The precise location and number and type of these openings will be determined during the exploration plan and will be documented in the Detailed Development Plan. The primary crushing facilities and mine maintenance facilities will be located underground.

C. Plant Facilities

A possible location for the plant complex for an underground mining operation would be the ridge separating Sorghum Gulch and Scandard Gulch (Figure 4). Other plant site locations are possible depending on the mine plan, disposal sites and overall environmental considerations. Land requirements for the processing facilities and product tankage for a 50,000 barrel per day complex are anticipated to be about 150 acres.

Some additional surface on the Tract will be required for the coarse ore stockpile (See Figure 4). During preproduction mining (before the plant startup) this stockpile will probably build up to several million tons. Most of this initial stockpile will be consumed during the first year of plant operation when the mine is still building up to its design capacity. Thereafter, a much smaller coarse ore stockpile will suffice to provide the necessary surge between the mine and plant. The size of this eventual stockpile and, consequently, the acres of surface land involved will be a function of overall mine and plant design to be determined in detailed design studies.

D. Disposal Sites

Several surface disposal sites for spent shale will be considered including both on-site and off-site areas. The selection of disposal

sites will depend on engineering and environmental considerations and the availability of lands external to the Tract.

Figure 4 depicts some of the disposal sites to be considered by the Lessees. As shown by the solid outline, spent shale disposal can be confined within the Tract boundaries. However, off-site disposal areas as indicated by the dashed lines may be more environmentally acceptable in that they follow the natural contours of the terrain and would facilitate diversion and collection of run off water and erosion control.

Initially, Sorghum Gulch could be used as a disposal site. It would be adequate for a 50,000 barrel per day operation for about 15 years. Other possible sites include the West Fork of Stewart Gulch and Scandard Gulch.

E. Storage Reservoir

Reservoirs may be required to impound imported river water or surplus ground water from the mine dewatering operation. The total reservoir capacity required, if any, will depend on the quantity of mine water encountered and methods selected for disposal or use in the plant facility. A possible location for a reservoir in Scandard Gulch is shown in Figure 4. By damming this drainage, a reservoir of large capacity could be created. Prior to any final reservoir site recommendation, an overall environmental assessment will be made to determine the consequences on land use in the immediate area and the affected lands

downstream. Any reservoir will be constructed following approved engineering practices and in accordance with appropriate regulations.

F. Utilities and Transportation

Tract C-b lies less than one mile from Piceance Creek Highway, which connects with State Routes 64 to the north and 13-789 to the east. Dirt roads extend from Piceance Creek Highway along the eastern and western sides of the Tract. Consequently, new road construction will mostly be limited to the Tract.

At least a portion and possibly all of the water requirements of the initial plant, estimated to be about 10,000 acre-feet per year, will be supplied from ground water produced during the mining operation. The quantity available from this source will not be known until hydrology studies and mine planning are completed. It is possible that additional river water may be required for the complex via a pipeline from a pumping station on the White River or Colorado River. Should water importation be required, the pipelines will be routed to follow existing transportation or utility corridors, where this is possible and determined to be the best solution.

Electric power for the complex will likely be supplied by a transmission system provided by a utility company. Figure 4 shows transmission lines from two general directions as possibilities. Reliable power is a necessity for the type of continuous operation complex proposed. Power should be available to the plant from more than one

generating source through whatever transmission system is used to ensure reliability at the plant. The total power requirement for a 50,000 barrel per day plant may be about 100,000 KW.

The feasibility of bringing a rail spur to the plant will be studied although grade and other routing considerations may preclude this as being practical.

It is expected that shale oil product will be pipelined from the Tract. The product slate and market destination will be determined at the time of plant design. A new pipeline would be required to connect with one of the network of existing pipelines in the general area. There are also two proposed pipelines now being considered by the Bureau of Land Management that would be in the general area of the Tract. At present, several possible pipeline routes appear feasible from an overall environmental impact and engineering standpoint. One of these is to the west and south to connect with a proposed pipeline to the Four Corners area for shipment to the West Coast, Gulf Coast, or mid-continent. Other possible routes are to the north and east to connect with existing, large common carrier pipelines in Wyoming for shipment into the mid-continent area. These possible product pipeline route directions are shown in Figure 5. Movement of sulfur, ammonia and other by-products, if any, will be handled by pipeline, rail or truck, depending on site logistics, transportation corridors, safety considerations and market conditions at the time.

Final routing of service corridors for roads, water pipeline, power

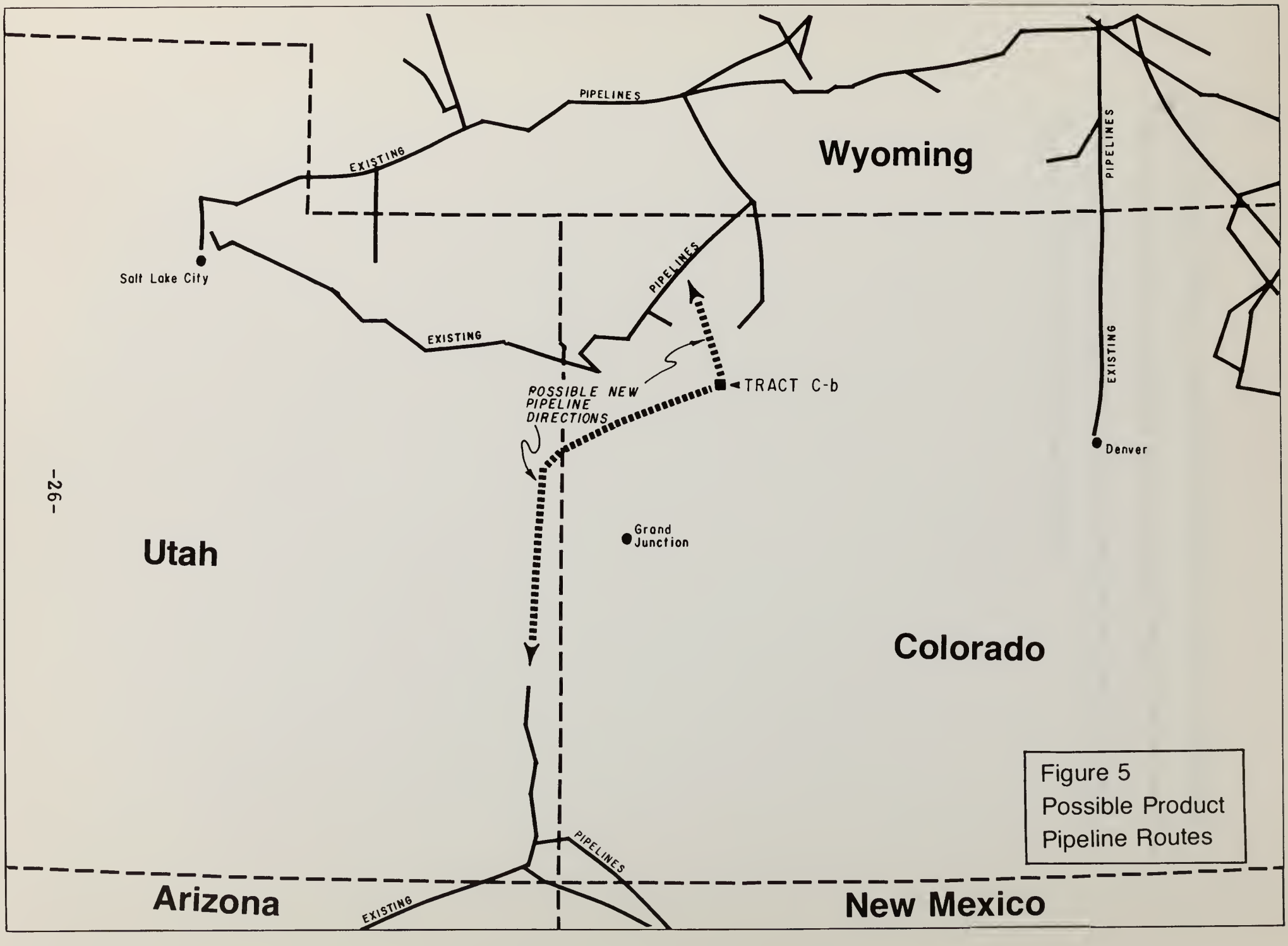


Figure 5
Possible Product
Pipeline Routes

line, product pipeline, rail spur and possible by-product transportation will be coordinated to establish common utility corridors where possible. Only general routes indicating possible direction are shown in Figure 4 for these utility and transportation corridors.

IV. ENVIRONMENTAL MONITORING PROGRAM

A. Introduction

The Lessees plan to undertake a series of environmental monitoring programs aimed at ensuring development of Tract C-b with minimal adverse environmental impact. These environmental monitoring programs will, (1) determine the physical and biological parameters on or near the Tract prior to operations, (2) monitor these parameters to document changes as they occur during and after development, (3) check continually on compliance with provisions of the Lease, and all applicable Federal, State and local environmental and pollution control requirements, (4) provide early notice of detrimental effects that may require correction, and (5) identify factual criteria for any desirable revision or amendment of the Stipulations. The broad range of environmental parameters will be studied in these programs including the physical environment (air, water, soils and geology), fauna and flora (wildlife, aquatic habitat and plant life) and the human/socio-economic environment. In carrying out the various environmental programs, the Lessees intend to use, in part, qualified consultants and contractors from private and/or public institutions. The Lessees recognize the importance of environmental protection and the need for careful planning through cooperation with public agencies, private organizations and citizen-groups. Such cooperation will be in addition to the extensive reporting requirements set forth in the Lease.

The Lessees will accumulate environmental baseline data as required by Sections 10 and 11 of the Oil Shale Lease and Section 1 (C) of the Oil Shale Lease Environmental Stipulations. Environmental baseline data will be collected for a period of at least two consecutive years. The Detailed Development Plan may be submitted after one year of baseline monitoring. If the Detailed Development Plan should be submitted prior to completion of the second year of baseline data acquisition, the Mining Supervisor will decide if any change in the Plan is necessary after all of the data are available. Although the baseline data program may be terminated after two years, environmental data collection will resume at least six months prior to commencement of operations and environmental monitoring will continue under the direction of the Mining Supervisor. A detailed description of the environmental monitoring program will be presented as part of the forthcoming Exploration Plan. In addition to the monitoring program, a series of special studies will be conducted dealing with socio-economic factors, community planning and land use.

B. Environmental Baseline Data Collection

1. Objectives

The primary objective of the environmental baseline data collection program is to collect the data necessary to establish the baseline environmental conditions prior to development operations in order to provide a basis for recording changes and minimizing

environmental impact and ensure compliance with the Lease terms, and Federal, State and local regulations.

2. Scope and Methodology

Baseline data will be collected on areas within Tract C-b and off-site areas, in accordance with the terms of the Lease and as directed by the Mining Supervisor. The baseline data collection will be a continuous year-round project using specialists qualified to perform the work required. Briefings will be conducted on a regular basis to review information, compare and discuss interactions among the various activities and modify the program as necessary. The Lessees also intend to utilize the extensive experience acquired by Colony Development Operation in conducting this environmental monitoring program.

3. Surface Water

The principal drainages on the Tract are Scandard Gulch, Sorghum Gulch, and the West Fork of Stewart Gulch, together with their tributary draws. None of the drainages appear to have a continuous flow onto the property, although because of local wells and springs, some flow usually occurs throughout the year at the point those drainages leave the Tract.

Gauging stations for continuous stream flow, water temperature and sediment measurement will be maintained on all continuous flow drainages on the Tract, both upstream and downstream of the Tract property lines. Continuous physical measurements will be collected,

including stream flow rates, water temperature, sediment load and precipitation. The intermittent nature of the stream flow will of necessity determine the continuity of the records. The Lessees will attempt to measure snow cover which may have possible ecological significance.

Selected inorganic and organic chemical measurements will be made periodically as determined by the Mining Supervisor. Precipitation gauges will be located at both high and low elevations on the Tract.

Gauging stations for drainages off the Tract will be established when operational impacts appear reasonably significant after discussion with the Mining Supervisor. Determination of the location of such stations will be made at the earliest practicable date, but will be dependent to a large degree upon exploration and development decisions which will be included in the Exploration Plan.

4. Ground Water

The Lessees will drill a test well at each proposed or actual mine site. An observation well will be installed in each water bearing zone defined by the test well. In addition, observation wells will be drilled at each disposal site with at least one well upgradient and two wells downgradient of the site. Geophysical logs will be run as required by the Mining Supervisor. Each water bearing zone will be pumped and

monitored for flow, temperature and level. Observation wells will be monitored for level and temperature. Water samples will be taken at initial pumping tests and at 6-month intervals, as directed by the Mining Supervisor, and analyzed for drinking water standards and other significant organic and inorganic constituents. The number and location of wells will be established when probable mine and disposal sites are determined and will be included as part of the Exploration Plan.

Subsurface water testing will also be conducted as directed by the Mining Supervisor to ascertain hydrologic condition prior to development and hydrologic changes throughout the life of the project. However, as an adjunct to these requirements, the Lessees believe that a comprehensive hydrologic data collecting program will be needed to provide a basis for predicting mine dewatering rates and to develop an acceptable water management plan. In order to compile the basic information for these interpretations, hydrologic testing will be conducted in certain of the exploratory core holes that will be drilled to evaluate the Tract during the exploration phase of this program. The types of testing necessarily would vary with need, but the program would be designed to gather information regarding the transmissivity, storage coefficient, direction of flow, extent of the aquifers , recharge, and chemical constituents.

5. Air Quality

The Lessees will establish at least four air quality measurement stations, one of which will be located nearest to the estimated point

of maximum concentration of emission. Stations will be equipped with automatic instruments with continuous recorders when applicable to measure concentrations of sulphur dioxide, hydrogen sulfide and particulates. Other substances, such as hydrocarbons and oxides of nitrogen will be monitored as deemed important by the Lessees or the Mining Supervisor.

A meteorological station and tower will be established near the proposed plant site and designed to continuously monitor wind direction and speed and humidity at three levels (at least 100-feet above the plant site, 30-feet above the plant site, and ground level), and temperature at two levels (at least 100-feet above the plant site and 30-feet above the plant site). Detailed meteorological baseline investigations will be undertaken to provide an adequate understanding of the local and regional atmospheric processes and their variability.

6. Flora and Fauna

The Lessees will conduct an inventory of flora and fauna on the Tract and for at least one mile outside the Tract perimeter, as well as on off-site disposal areas and special aquatic habitats as required by the Mining Supervisor. An inventory will be conducted of vegetation stands.

An inventory, sampling and analysis of fauna in the study area will be taken. Deer, considered to be the wildlife species of greatest social significance, will be given special attention. The Lessees will study

and report on the ecological interrelationships including migratory patterns of birds, mammals, and fish and plant animal relationships. The existance of possible endangered species on the Tract will be determined and inventories will be conducted if a need is established. The Lessees will also inventory the natural surface waters, such as springs and seeps as they relate to wildlife and aquatic habitats.

Flora investigations will include the cataloging and mapping of the plant species on and adjacent to the Tract to determine their distribution and density. With this basic knowledge, experimental plots or other methods will be used to monitor any possible vegetational changes during the lifetime of the project. Verification of the presence or absence of rare or endangered plant species will be a part of the initial flora catalog. Flora investigations will include such studies as vegetation types and species components of habitats, successful trends, tolerance range of species, recovery patterns and role of vegetation components.

7. Soil Survey and Productivity Assessment

The Lessees will conduct a soil survey and productivity assessment of all lands which may be disturbed under the development operations. The soils of the areas under study will be cataloged and mapped, including soil type, strike and dip of the material, slopes, solar exposure, vegetative cover and erodibility. Soil information will be particularly important in analyzing the impact of spent shale disposal, revegetative characteristics, water erosion, acceptability to construction, and

possibly the stockpiling of high value soils for later revegetation.

C. Continuing Environmental Monitoring Program

The Lessees intend to conduct a continuing environmental monitoring program during exploratory and development operations on the Tract. The environmental baseline studies described above will be an integral part of the continuing environmental monitoring program and will serve as the basis for data gathering during and following operations on the Tract. The Detailed Development Plan will present the baseline data collected during the exploratory period and describe in detail the continuing environmental monitoring program. The Lessees anticipate continued monitoring of air and water resources, fauna and flora, and soils conditions will be necessary.

D. Special Studies

1. Regional Socio-economic Factors

Oil shale development will have a substantial impact upon existing socio-economic patterns in Rio Blanco, Garfield, Moffat, and Mesa Counties. The local governments in these areas have been advised by state officials, the U. S. Department of Interior and industry that large scale development of the area's oil shale will be of major significance and may strain existing resources. Comprehensive regional planning will be required to provide a proper basis to plan for orderly development of communities, water and sewage facilities, roads, transportation, schools, health and governmental services, and other amenities needed by the increasing population.

The Lessees through Colony Development Operation can acquire a substantial amount of data and information concerning regional population patterns, governmental entities, public facilities, transportation routes, and other demographic factors. Such information will be updated on a regular basis for the region which might be affected by the project, and such information will be made available to the Lessor.

2. Population and Community Planning

The impact of the exploration and development of the Tract on population patterns will depend on the results of the ongoing programs and the mining and processing methods employed. The Lessees intend to update estimates of workforce requirements in the Exploration Plan and the Detailed Development Plan.

The Lessees plan to cooperate with appropriate local and regional planning agencies. A cooperative effort is needed to assure a stable and healthy economic climate and living environment in the oil shale development region. The Lessees believe that the Tract can be developed with net positive social economic and environmental benefit to the existing and future residents of the area.

3. Land Use Planning

Extensive land use planning studies will be carried out to determine the proper siting of on-site and off-site facilities. These

investigations will consider the economic and environmental factors in siting mine, plant, disposal sites, utility and transportation corridors. The Lessees intend to work with public agencies to determine the most suitable sites for the timely development of the Tract.

4. Fish and Wildlife

The Lessees will submit a Fish and Wildlife Management Plan as part of the Exploration Plan and Detailed Development Plan. That plan will describe means to be pursued for avoiding or minimizing impact on fish and wildlife, restoring damaged habitats, providing for alternative habitats, and controlling access to permit public enjoyment of the wildlife resource.

5. Surface Rehabilitation and Revegetation

The Lessees will rehabilitate all affected lands to conditions consistent with the baseline conditions established in the environmental baseline monitoring program. Conventional methods for restoring disturbed or affected surfaces, such as leveling, grading and back-filling will be used to establish contours consistent with the natural terrain. Restoration procedures will include the revegetation of affected areas to minimize erosion and reestablish vegetative conditions approximating those present during the baseline monitoring period. The Lessees can acquire substantial information and data on the rehabilitation and revegetation of spent shale disposal areas

through the extensive experimental studies conducted by Colony Development Operation.

As a part of the Exploration Plan and Detailed Development Plan, the Lessees will submit an Erosion Control and Surface Rehabilitation Plan. All rehabilitation activities will be conducted in accordance with the Plan with revisions as approved by the Mining Supervisor.

6. Historic Scientific and Scenic Investigations

A thorough survey will be conducted by trained archaeologists to identify objects of historic and scientific interest such as Indian ruins, pictographs or artifacts. Sites of value will be identified and any in the path of construction work will be excavated first.

The scenic condition will be recorded for mine, plant and disposal sites as well as connecting roads, service corridors and off-site locations that might contain the expanded population and service facilities so that a basis will be established on which to make periodic scenic reassessments.

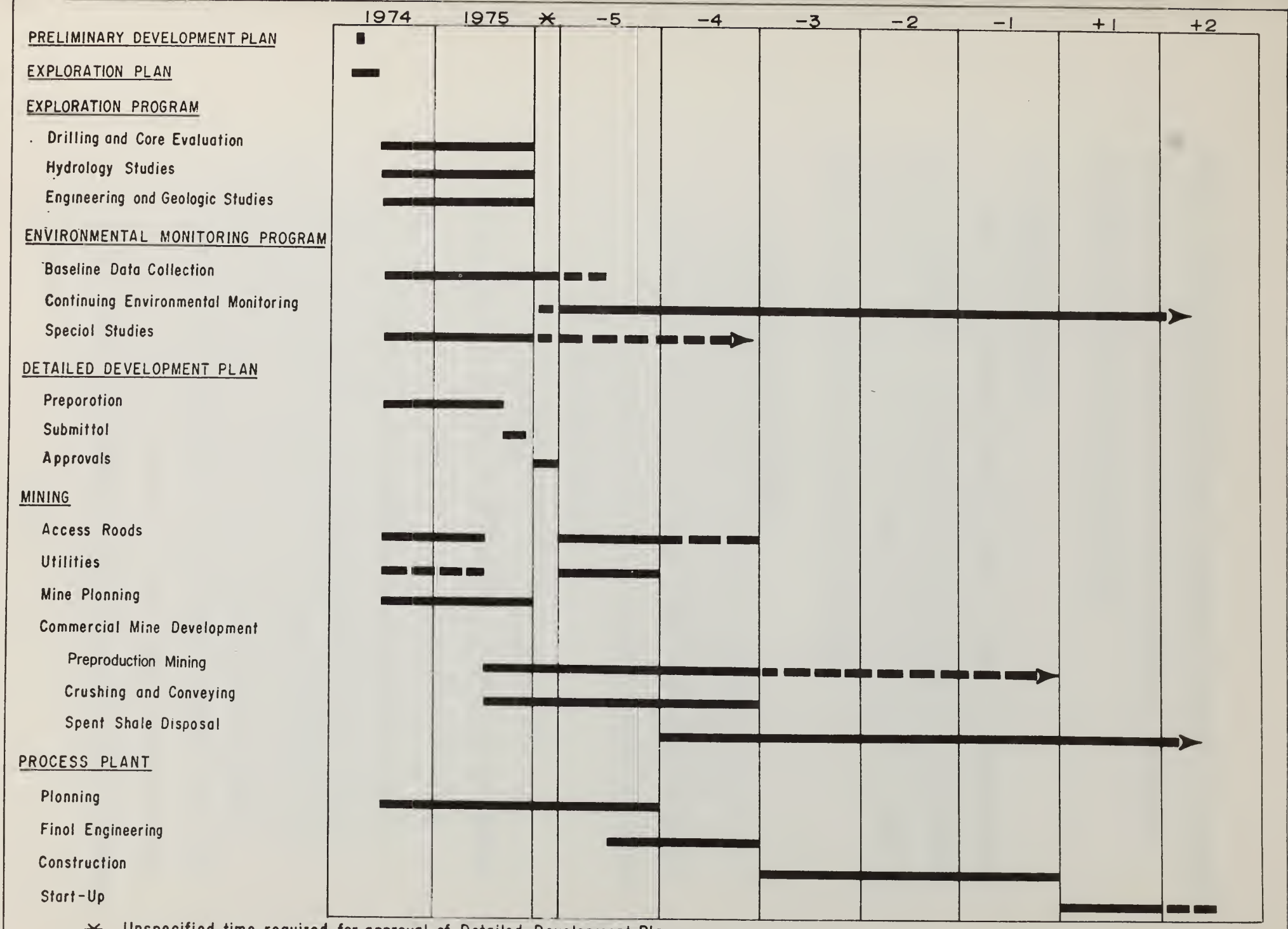
V. PROPOSED SCHEDULE FOR DEVELOPMENT

A. Introduction

A preliminary schedule of the activities leading to an initial plant production of about 50,000 barrels per day of shale oil is presented in Figure 6. The schedule shown provides for early development of Tract C-b without committing undue expenditure of funds for construction prior to approval of the Detailed Development Plan. The schedule presumes application of presently available technology and does not include programs for development of new technology in the fields of mining, retorting or oil processing. However, the Lessees intend to conduct continuing investigations for the purpose of planning and implementing, if economically and environmentally feasible, the timely expansion of the of the initial plant. A discussion of the overall development activities shown in Figure 6 follows.

B. Exploration Plan

Preparation of a plan describing the exploratory work proposed to be undertaken on the Tract will be commenced promptly upon execution of the Lease. Exploratory work, as defined in the Lease, includes, but is not limited to, seismic work, drilling, blasting, research operations, cross-country travel, the construction of roads and trails and other necessary facilities, and the accumulation of baseline data required in the Environmental Stipulation portion of the Lease. It is the intention of the Lessees to work closely with representatives of the appropriate



* Unspecified time required for approval of Detailed Development Plan.

Figure 6. PROPOSED DEVELOPMENT SCHEDULE

Federal, State and local governmental agencies to develop an acceptable Exploration Plan. Submission to the Mining Supervisor and approval are scheduled for the second quarter of 1974.

C. Exploration Program

Upon approval of the Exploration Plan, a series of special programs will be commenced to define more precisely the physical characteristics of the Tract. These will include drilling and core evaluations, hydrology studies, and the geologic and engineering studies.

1. Drilling and Core Evaluation

A core hole drilling program will be initiated upon approval of the Exploration Plan. The objectives of this program are to obtain:

1) oil shale and accessory mineral resource information
2) hydrologic data and
3) rock mechanics mine design information.

Actual well locations will be staked and acceptable routes marked on the ground to make maximum use of the natural topography, achieve harmony with the landscape and cause minimum disturbance to the ecology. Proper safeguards will be taken during drilling operations to protect the air, ground and surface water quality of the area. The drill holes will be properly plugged in accordance with instructions from the Mining Supervisor once such holes are no longer required in the ground water monitoring program. The core drilling and evaluation program will require about 18 months to complete.

2. Hydrology Studies

A detailed study of the ground water system will be required both for mine design and environmental monitoring purposes. In order to establish the location of aquifers and the quantity and quality of water therein, a number of wells will be completed and pumped while monitoring the effects. Some of the core holes will be completed as wells for this purpose, but additional monitoring wells will likely be required. Fielding of this program will be concurrent with the drilling and core evaluation program.

3. Engineering and Geologic Studies

Commencing with the approval of the Exploration Plan, detailed engineering and geologic studies will be undertaken of the Tract and surrounding area. These investigations will include geologic and topographic mapping, aerial photography, seismic investigations, and foundation studies. These investigations will run concurrently with the drilling and core evaluation program.

D. Environmental Monitoring Program

The Environmental Monitoring Program will involve environmental baseline data collection, continuing environmental monitoring program and special studies.

1. Environmental Baseline Data Collection

Promptly after approval of the Exploration Plan, environmental equipment will be fielded and environmental baseline data will be collected in accordance with the approved Exploration Plan.

2. Continuing Environmental Monitoring Program

Environmental monitoring will continue as an extension of the baseline data collection program. The monitoring will continue, as approved by the Mining Supervisor until and after conclusion of operations on and near the Tract.

3. Special Studies

Special studies will be conducted, including regional socio-economic factors, population and community planning, fish and wildlife, surface rehabilitation and revegetation, and historic, scientific and scenic. These investigations will commence with the approval of the Exploration Plan.

E. Detailed Development Plan

The Lessees plan to submit to the Mining Supervisor for approval a Detailed Development Plan as soon as practical after collecting environmental baseline data for one year.

Since little is known at this time about the procedures or time required to secure approval of the Detailed Development Plan, the schedule in Figure 6 shows a gap at this point. Subsequent activities are measured backward from the most likely time of commercial plant startup; i.e. "year - 5" is the fifth year before commercial plant startup.

F. Mining

1. Access Roads and Utilities

The construction of access roads and utility lines necessary

to carry out the exploration program will commence shortly after approval of the Exploration Plan. Maximum use of existing roads and trails will be made. Initially only secondary power utility lines will be required to support monitoring and exploration work. Additional access roads and utility lines will be constructed for mine and plant facilities only after approval of the Detailed Development Plan.

2. Mine Planning

Commercial mine planning will commence shortly after the exploratory work has begun. Initial efforts will be aimed at locating and designing the initial mine shaft and planning commercial mining activities including site layout and surface mine plant facilities. This work may be done by Lessees working with an engineering-contractor firm retained for mine design activities. Scheduling will be an important part of this planning phase.

3. Commercial Mine Development

a. Preproduction Mining

Preproduction mine activities may commence in the second Lease year. Initial efforts will include final design of the initial mine shaft, specifying and procurement of mine equipment for initial mine activities. If approved, construction of the initial shaft could commence during the exploration program. This effort would include rock mechanics and mine dewatering programs essential to commercial mine planning and the initial opening would likely be part of the commercial mine.

Preproduction mining will be carried out to develop underground areas for shops, primary crusher installation and initial mine layout. Oil shale mined during this period may be primary crushed and stockpiled as coarse ore for eventual plant startup.

b. Crushing and Conveying

If the initial mine shaft is constructed during the exploration program, some crushing and conveying equipment may be ordered or procured. In the first year following approval of the Detailed Development Plan, sufficient crushing and conveying equipment may be delivered to commence preproduction mining, primary crushing and coarse ore stockpiling.

c. Spent Shale Disposal

Engineering and preparation of disposal sites for spent shale will begin in the second year following approval of the Detailed Development Plan. Conveying and disposal equipment will be procured and installed during this period. Disposal operations will begin in the first year following plant startup.

G. Process Plant

1. Planning

Planning for the process plant and related offsite facilities will begin immediately after approval of the Exploration Plan and proceed concurrently with mine planning and later preproduction mining. Prior to submittal of the Detailed Development Plan, the design basis for the commercial plant will be established.

2. Final Engineering and Construction

It is anticipated that the final engineering and construction activities will commence promptly on approval of the Detailed Development Plan. Approximately three years will be required to complete construction of all facilities after final design is complete and field construction has commenced.

3. Plant Startup

Plant startup and commercial production of shale oil is anticipated after the fifth year following approval of the Detailed Development Plan. A one year plant startup period is shown after which full design capacity is assumed. During the first year, operation at 50% capacity would be expected while operating problems are resolved.

H. Employment

Oil shale development on Tract C-b will create both temporary and permanent jobs. The Lessees expect that local people will fill some of these openings.

During the first two or three years of the lease development activities up to 50 people may be employed in the field at various times to conduct exploratory work on or close to the Tract. This estimate will be updated after exploration planning is completed. The early field workers mainly will be carrying out core drilling and related hydrologic measurements

and all of the environmental programs described elsewhere in this Preliminary Development Plan.

Preliminary planning and engineering for mining and plant operations will build up in intensity during the first two years. Most of this work will be conducted in Lessees' offices in Colorado or outside of Colorado rather than on the Tract. After about one year, the Lessees may begin substantial engineering work at an engineering-contractor firm which may be located outside of Colorado. Most of this work would be done by employees of the engineering-contractor firm.

Final engineering and construction of the mine and plant facilities may result in a peak construction employment of about 2000 people, midway through the construction period.

Permanent mine and plant employment is estimated to be about 1000 people for a 50,000 barrel per day plant operation.

Form 1279–3
(June 1984)

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